// AMYGDALA $z \mapsto z^2 + c$

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A Newsletter of fractals & $\mathcal{M}$ (the Mandelbrot set)
AMYGDALA, Box 219, San Cristobal, NM 87564
505/758-7461 (currently)

Current issues:
- $15.00 for ten issues (#11-20) ($25 overseas)
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- $16.00 for newsletter issues #1-10 ($21 overseas)
- $16.00 for first 25 color slides ($18 overseas)

Issue #10
April 26, 1988

CONTENTS

COMPLETION

This issue #10 of *Amygdala* marks the end of the first series of newsletters. For those of you who have the color slide supplement, the four slides enclosed herewith complete the first series of slides. If at this point you haven't gotten newsletter issues 1a-10 and (if you've subscribed) 25 slides, please let me know!

If you haven't yet renewed your subscription(s) and wish to do so, see the enclosed Renewal Coupon.

SUBSCRIPTION DRIVE

A. K. Dewdney's column *Computer Recreations* — which appears monthly in *Scientific American* — is probably read by more fractal lovers than any other publication. Thus, when Kee mentioned *Amygdala* in the March, 1988 issue, the deluge of mail that ensued could have been expected. The resultant huge increase in the number of subscribers (see page 8) has only whetted my appetite for more — and here, dear reader, I would like to enlist your aid.

I believe that a further increase in the number of subscribers would be to your benefit, as well as mine, and would improve the quality of material in the newsletter, as well as its appearance, and would allow me to spend more time working on the newsletter, to hire help to do the dog-work, and actually to get paid a bit for doing what I do.

If you dig it, here's how you can help: You can tell your fractally inclined friends about *Amygdala* (and the slides) and encourage them to subscribe; you can post items about the newsletter on computer bulletin boards, and write about it to your favorite publications. I'm sure that you can think of many more ways to bring awareness of *Amygdala's* existence to the attention of those who might want to subscribe.

THE SLIDES

The color slide supplement, first series, concludes with four more slides sent to subscribers with this issue. These slides were created by Ken Philip, and quoted comments are by him. "All magnifications are based on a 'standard' display with a real-axis side length of 3 (so my mags are *not* equal to the mag quoted in AMY #9 for Fitch's puzzle picture. I get about 5000 diameters for what he calls 3690.)"

#339: Progression of double spirals, yellow against blue. "This is taken in what might be called 'Seahorse Valley prime' — the valley between the 'head' of the Mandelbrot Set, and the 'subhead' or 'head prime' to its left. The sceptre-like structure (shown here much magnified) is found superimposed on all the spirals and seahorses on both sides of the valley. Each 'sceptre' is composed of a chain of linked double spirals."

Center = -1.26446153 + 0.04396696i; magnification = 54,000.

#405: "The 5-rayed star is a slightly magnified view of the center of the cross attached to the northwest wart on the main body of the Mandelbrot Set, using the 'contrast' CLUT in Robert Woodhead's MandelColor 5.5. There appears to be no midget at the center of the star (at least up to a magnification of several billion diameters)."

Center = -0.56100 + 0.64277i; magnification = 360.

#466: "A view of the double spiral on page 3 of AMYGDALA #6, at about 1/18th the magnification of that picture. The double spiral is in the very center of the slide (not the much larger one to the right of center). This scene is on the west side of the Seahorse Valley *below* the real axis."

Center = -0.7739 - 0.1126; magnification = 105.

#492: A lovely double-spiral contemplating itself, pale green against blue and violet. "... from the west side of Seahorse Valley (above the real axis), similar to the largest spiral in #466."

Center = -0.763716 + 0.094921; magnification = 580.

"All these slides were done with MandelColor 5.5 (#405 with the 'contrast' CLUT) using a maximum dwell of 240, 240 colors (except #405), and an escape radius of 100. The computer was a Macintosh II with the AppleColor High Resolution RGB Monitor; camera was a Nikkormat with the 200mm internal focussing MicroNikkor macro lens."

SLIDE NOTES

—*From Charles Fitch*

Here is clarification of the data for my 'challenge' picture [#600, distributed with Amygdala #9] which, if I didn't mention before, is entitled *Buddha's Garden*.

Image size (x,y) in pixels = 2560 x 2048;
Image center = -0.776785376 + 0.13576353i;
Lower left corner = -0.777124226635593 + 0.135492475974576i;
Upper right corner = -0.776446525364407 + 0.136034584025424i;
Zoom = 34,810,000 x area, or 5,900 x side length;
Center = -0.776785376 + 0.13576353;
Picture rectangle: 6.77966101694915 x 10^{-4} wide, 5.42372881355932 x 10^{-4} high.

Finally, to pique your interest is my first view of the interior of $\mathcal{M}$ [slide #601]. Each point is colored according to the curvature of the path of convergence. I'll send a more detailed article later. [This striking slide will be distributed in the second series.]

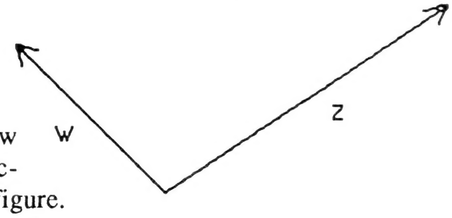
TUTORIAL: THE GEOMETRIC REPRESENTATION OF COMPLEX NUMBERS

Let's again go over the geometric representation of complex numbers, first taken up in Amygdala #1 (page 2).

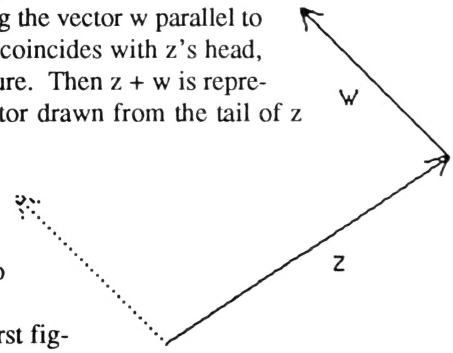
A complex number z = a + ib can be represented as a point in a plane having a rectangular coordinate system: the point (a,b) with coordinates x = a, y = b. The x-axis is the *real axis*, and the y-axis is the *imaginary axis*. The plane is the *complex plane*. This geometric representation allows us to use the vivid mental pictures associated with geometrical language in dealing with complex numbers. We will also regard a complex number as a *vector:* the vector from the origin to the point.

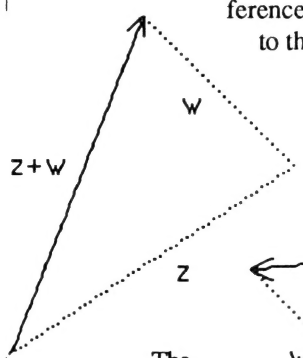
Geometric Addition and Subtraction. By representing complex numbers as points in the complex plane, their addition becomes *vector addition.*

The complex numbers z and w are shown as vectors in this first figure.

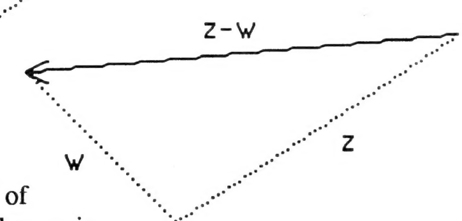


We add them, to get the sum z+w, by translating the vector w parallel to itself until its tail coincides with z's head, as in this next figure. Then z + w is represented by the vector drawn from the tail of z to the head of w, as in the figure below.

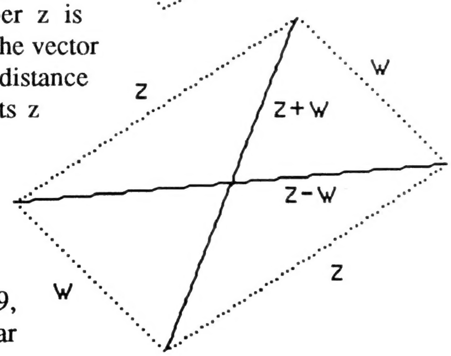




We can subtract w from z, to get the difference z - w, using the first figure: the difference vector is drawn from the head of z to the head of w, as shown below.



Note that z + w and z - w are the diagonals of a parallelogram having sides z and w, as shown in the last figure.

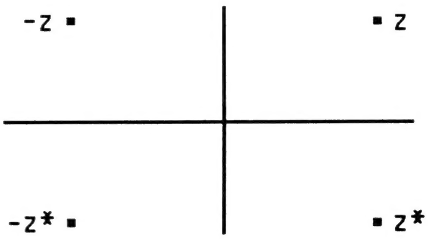


The magnitude $|z|$ of a complex number z is just the length of the vector z. Therefore the distance between the points z and w is just $|z - w|$. The *triangle inequality,* $|z + w| \le |z| + |w|$, that we discussed in Amy #9, becomes a familiar

geometrical theorem under this geometrical interpretation, as does the *parallelogram identity:*

$|z + w|^2 + |z - w|^2 = 2(|z|^2 + |w|^2)$, presented at the end of the tutorial in Amy #8.

The point z and its conjugate z* are symmetric around the real axis; The points z and -z are symmetric around the imaginary axis; the four points z, z*, -z, -z* are the vertices of a rectangle symmetric about both axes.



THE DACE JULIA SETS

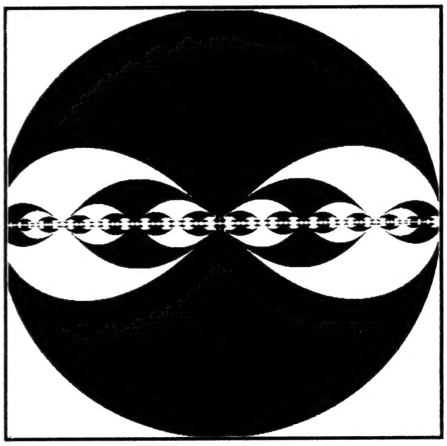
— John Dewey Jones writes:

I am transmitting some Julia sets produced by Dr. Martin Dace, inspired by Esseh Namreh's "Journey to the West" in Amy #5. I believe these were produced on a BBC Acorn, using software written in *Forth.*

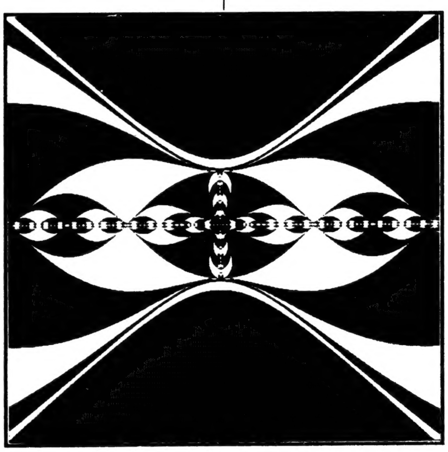
RS comments: The figures below are the Dace Julia set for c = -1.99638 at six different magnifications, from ×1 to ×1000. The pinstripes are presumably a Forth "feature". At the lower magnifications of Dace we are looking at something very like the uttermost West at high magnifications (Amy #5, page 3). As the magnification increases a core object rises up in view — voila! it is not an $\mathcal{M}$ midget, but rather a San Marco microdragon! In *The Fractal Geometry of Nature* Dr. Mandelbrot writes: "This is a mathematician's wild extrapolation of the skyline of the Basilica in Venice, together with its reflection in a flooded Piazza; I nicknamed it the *San Marco dragon.*" (page 185). Is this figure as ubiquitous in microscopic details of those Julia sets $z \mapsto z^2+c$ for which $c \in \mathcal{M}$ as the $\mathcal{M}$ midget is in details of $\mathcal{M}$?

— Martin Dace writes:

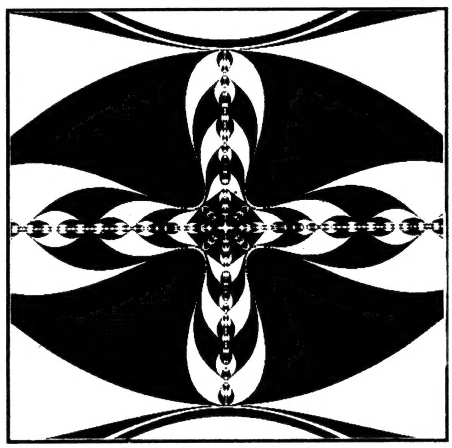
How many angels can dance at the end of a pin? I don't know, but if the pin is the spike of the Mandelbrot set, and we look at the Julia set corresponding to the "John Dewey Jones midget' (AMY #5) near the end of the pin (at -1.99638), then we can see that the number of angels doubles for every increase in dwell of six.



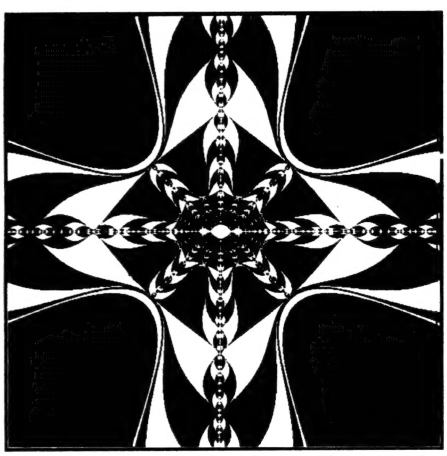
×1



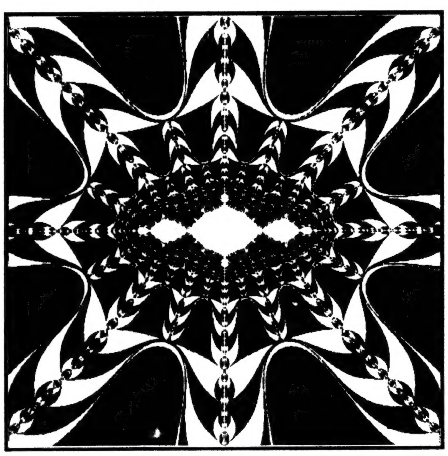
×10



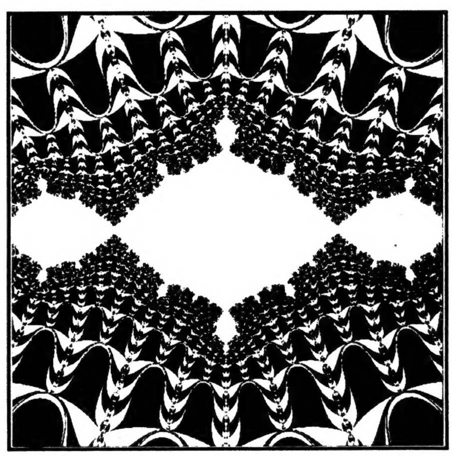
×33



×100



×330



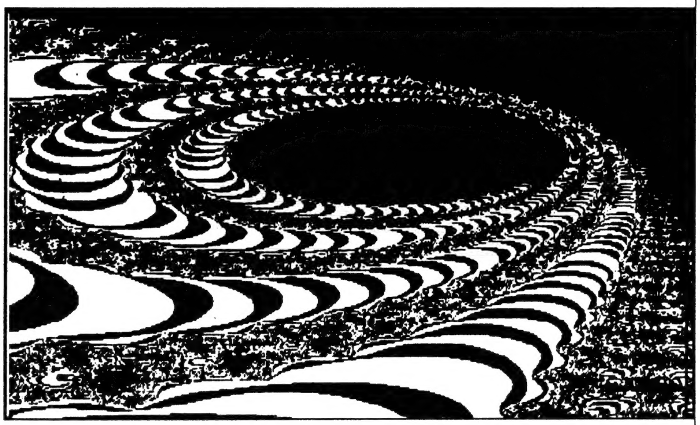
×1000

FRACTAL MUSIC

—Richard V. Robinson

I have been creating a computer program which permits me to generate and manipulate color representations of the Mandelbrot set, Julia sets, and various others which I construct as the need arises.

My hardware consists of an IBM PC-compatible computer equipped with EGA video, so my plots are restricted to 16 on-screen colors and a barely acceptable resolution of 640 by 350 pixels. My configuration includes an 80287 math coprocessor. Even with this unsophisticated equipment I'm finding I can create fairly attractive graphics, and I am enclosing a black-and-white print of one of my more successful efforts.



Right now, the part of my program which is receiving the most attention is a routine that generates sequences of notes in equal-tempered intervals, interspersed with periods of silence. I use the shape of the border between points which are members of the Mandelbrot set and those which are not to determine when to make sound and when silence, as well as the direction of each interval.

So far, I hesitate to call the resulting output "music," but it does display rhythmic variation and repetition, as well as melodic qualities of inversion, retrograde motion, sequencing, and transposition. I am very curious to know whether any contemporary composers are making use of the concepts involved in chaotic dynamic processes in as comprehensive a way as, say, Iannis Xenakis employed those of stochastic probability processes a generation or two ago.

The enclosed tape contains "Two Tunes from Halo-X", which are samples of the output of my noise-making program. The first little ditty is generated by a walk around the inside circle of the big spiral in the picture. After a few gratuitous clicks, there is a tune made from four excursions around one of the dark blots toward the bottom center of the picture. The noise itself is made by the speaker on my PC. Sorry about the tinniness. No doubt when you hear the tape, you'll appreciate my reservations about calling it "music".

The picture is a Mandelbrot set blowup representing the area from -0.749969+0.012896i to -0.749956+0.012920i. In the picture, the imaginary axis is upside down, i.e. it increases from top to bottom. To reproduce my result with a program that employs a conventional Y-axis orientation, you need to swap the imaginary coordinates and negate them.

RS comments: Richard sent along a tape with a few seconds of songs of the Mandelbrot Set, which he modestly deprecates — I found the songs fascinating. If any of you out there *must* have it, I'll send you a copy for $5.00, — but please don't complain that you've been gypped! The recording is very short and *very* low-fi. *Caveat Emptor!*

FRACTAL SOFTWARE REVIEWERS

If you have fractal software for the following computers and you'd like it mentioned or reviewed in *Amygdala,* send it to the designated reviewer/contact. If you want copies of material mentioned or reviewed in these pages, request it from them. The cost of material is up to them.

— for IBM PC and Compatibles
Dan Lufkin
303 West College Terrace
Frederick, MD 21701
301/662-8727

— for Commodore Amiga
Tom Granvold
1087C Reed Ave
Sunnyvale, CA 94086

— for Timex-Sinclair
Bob Howard
750 North Yaleton Avenue
West Covina, CA 91790

— for Macintosh II
Ken Philip
1590 N. Becker Ridge Rd.
Fairbanks, AK 99709

— for Macintoshes other than Macintosh II
Rollo Silver
Amygdala
Box 219
San Cristobal, NM 87564

The idea, as proclaimed in Amygdala #2, is as follows:
(1) For each computer X used by a nonempty set of subscribers, let one subscriber volunteer to be the reviewer and contact ("Contact X") for fractal software for computer X. I will print the names and addresses of these contacts.
(2) If you create or acquire a fractal software diskette for computer X, and want to share it with other Amygdala readers, you should send it to Contact X.
(3) Contact X will examine and digest each FSD sent to him, and send a short review for publication in Amygdala. The review should indicate where copies of the diskette may be obtained.

(4) Contact X agrees to provide copies of FSDs which are freeware or shareware to subscribers on request for a nominal fee (I suggest $5.00 - $10.00).
(5) If the workload for computer X grows too heavy, I will supply to Contact X the names of alternates who are willing to share the load.

REVIEW: "A BETTER WAY TO COMPRESS IMAGES"

A Better Way to Compress Images, by Michael F. Barnsley and Alan D. Sloan, appeared in the January, 1988 issue of BYTE magazine (pp 215-223). Barnsley's pioneering work on representing fractal images mathematically by means of "affine transformations" can also be used to achieve a high degree of image compression — reduction of the number of bits required to represent a visual image (See Amy Bibliography #52 and 53). The method has yielded compression ratios of 10,000 to 1, bringing a high-detail gray-scale aerial photograph requiring 130 megabytes of computer memory down to 13,000 bytes.

The method starts with a digitized image. "Using image-processing techniques such as color separation, edge detection, spectrum analysis, and texture-variation analysis, we break up the image into segments. ... A segment might be a fern, a leaf, a cloud, or a fence post. A segment can also be a more complex collection of pixels: A seascape, for example, may include spray, rock, and mist."

These segments are then looked up in a library of fractal representations called *iterated function system* (IFS) codes that will reproduce the corresponding fractals. IFS theory is an extension of classical geometry. "It uses affine transformations ... to express relations between parts of an image."

The article includes five colored images (figures 1-5) which are the IFSA-coded color images of: 3-D ferns (100 bytes), Black Forest (2,000 bytes), a Bolivian girl (2,000 bytes), the Monterey coast (100 bytes), and a Cloud Study (500 bytes).

The authors give a detailed mathematical exposition of affine transformations, with a number of examples, including a leaf, a fern, and the Sierpinski triangle. They discuss their Random Iteration Algorithm for reconstructing an IFS-compressed image, and give a BASIC program demonstrating its use. They also discuss their Collage Theorem, which provides "a systematic method for finding the affine transformations that will produce an IFS encoding of a desired image." A collage is a set of affine transformations of an image whose union approximates the target image. "The Collage Theorem says that the more accurately the image is described in this way, the more accurately the transformations provide an IFS encoding of it."

"A full-sequence video animation, *A Cloud Study,* was shown at SIGGRAPH '87. This was encoded at a ratio exceeding 1,000,000 to 1..."

CONCERNING MIDGETS

- John Dewey Jones

Dr. Martin Dace has communicated to me a conjecture concerning midgets, which I have tentatively confirmed. He has written ... an informal statement of the conjecture, which I try to formalize below.

Concerning Midgets

We adopt the terminology introduced by Esseh Namreh in Amy #5. That is, we call the miniature analogues of the Object along the Spike 'midgets', we refer to the boundaries between regions of constant dwell ('monochromatic' regions) by the letters D_n, and to the regions of constant dwell themselves by K_n, $1 \le n \le \infty$. As Namreh observes, "where the contours press in toward the real axis, the compression seems to create a Mandelbrot replica." For the present, we confine our attention to the replicas created by the *first* compression found in each region as we move in the positive real direction from the Uttermost West. The replica created by the first compression in K_n we will call $M_n{}^1$. The Biggest Midget is then $M_3{}^1$, and the John Dewey Jones midget is $M_6{}^1$. Each midget is surrounded by contours similar to the petals of a flower; as we move in towards the midget, the number of petals increases. (If a more formal definition of a 'petal' is required, we identify petals with local maxima in $|z_0 - z|$, where z_0 is the centroid of the midget and z is a point on the contour.)

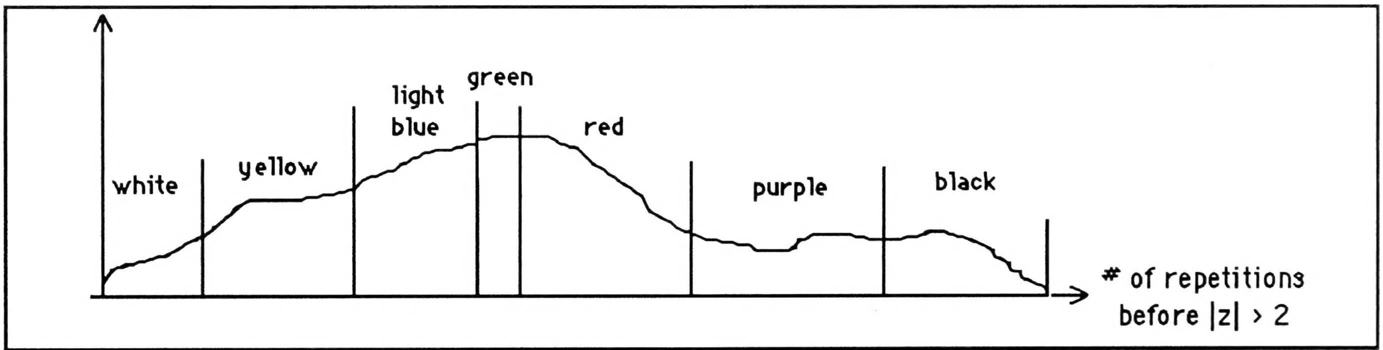
The conjecture is that, as we proceed inwards towards the midget $M_n{}^1$, the number of petals doubles every *n* contours. (For the midgets $M_3{}^1$ and $M_6{}^1$, this is true by inspection.)

In addition to the midgets $M_n{}^1$, there are an infinity of second-, third-, and higher-order midgets created by subsequent compressions in each of the regions. We can refer to the midget created by the *m*-th compression in the *n*-th region as $M_n{}^m$. Namreh's 'Topknot' is then $M_4{}^3$, etc. Two questions: can the conjecture, if true, be extended to higher-order midgets? And, is there an analytic expression of the form x = f(m,n) giving the position of midgets on the real axis?

One further observation: if we turn to p.11 of TBF, which shows a correspondence between the midgets and the Verhulst period-doubling diagram, we see that $M_3{}^1$ corresponds to a rarefaction in the diagram crossed by three lines. We conjecture that every midget $M_n{}^1$ corresponds to a rarefaction crossed by n lines.

Commentary by John Jones

I have checked the Dace conjecture for $M_4{}^1$, located in the region $(-1.949 \le R(z) \le -1.933),(-0.0065 \le I(z) \le 0.0065)$ and for $M_5{}^1$, located in $(-1.9858 \le R(z) \le -1.9852),(-0.00028 \le I(z) \le 0.00028)$, and it is true for both cases. I am preparing



slides of both midgets and will send copies in a few weeks.

A NOVEL PALETTE TWEAKER

A device probably in use, but which I have found useful for displaying Mandelbrot sets, is to display a bar chart of frequency of repetitions, display the colour values as lines, and then move these lines to change the colours, as this makes it easier to see clusters, e.g.: [figure above].

Jim Dallas
Wadham College
Oxford, OX1 3PN
ENGLAND

AUTHORS

Dr. Martin Dace was fired from his post at the Theological Department of the University of Altair for his heretical views. He now works as a family doctor in south-east London, England.

FRACTAL MUSIC is by *Richard V. Robinson*, 616 23rd Avenue East, Seattle, WA 98112. "I've been involved with music for over twenty years. My primary instruments are saxophone and flute, and my interests center on improvisational music. I've been involved with computers for a little over ten years now, doing programming, systems administration, data base design, training, etc., in business and government settings."

ERRATA

Three typos which appeared in Amy #9 should be corrected as follows:

Page 6, column 2, line 32 : "knot" for "know".
Page 7, column 2, line 17 : "note" for "not".
Page 7, column 2, line -8 (8 up from the bottom): "primitives" for "primites".

ANI-MANDEL

— *Mark R. Lankton*

I hope that the idea of receiving yet another Mandelbrot-and-Julia-set-generating program is not too dismaying. I am enclosing an application I wrote recently which has been well received by those who have downloaded it from GENIE.

Ani-Mandel runs on a Macintosh II. It requires at least 2 megs of memory (it stores a large internal file) and 8-bit color. It calculates and displays arbitrary areas of the Mandelbrot and Julia sets, using a number of iterations set by the user (32K maximum) and a number of colors set by the user (256 maximum).

Once the display has been created, individual colors can be changed one by one, if desired, to fine-tune the appearance. As a final bit of fun, the display can be animated. This can produce startling effects, ranging from awe to mild headaches.

1275A Bear Mountain Drive
Boulder, CO 80303

RE COMPUTER BASHING

— *Ken Philip*

I was amused (sadly) by the letter from George Zopf in AMY #9, in which he attacked IBM and Apple for being overpriced. I thought to myself: "He must be an Amiga or Atari ST user", and lo and behold, in his first ¶ he mentions Amiga color graphics!

I have seen *exactly* this kind of strident anti-Apple diatribe from Amiga and ST owners on local BBSs in Fairbanks. The phenomenon is known as 'computer-bashing', and is rampant on bulletin boards. May I suggest that you, as editor of AMY, can do quite a bit to tone down that sort of thing, if you care to?

I feel that computer-bashing is inappropriate for a newsletter devoted to the Mandelbrot Set. I have no quarrel with someone sending in a Mandelbrot picture and saying: "I did this on my such-and-such in so many seconds with so many colors" — that is factual information that might help someone decide what computer to get. But I feel that as editor you should weed out undocumented attacks on *any* brand of machine. The point of AMY is the Mandelbrot Set, not the Mac II or the Amiga, or what have you! And I would *hate* to see AMY turn into a forum for computer-bashing — that's not what I subscribed to it for...

All this is merely one subscriber's viewpoint — the decision is yours to make, of course.

By the way, I must admit I am curious to know what machine Mr. Zopf thinks can match the Mac II at one third the

price for Mandelbroting. I have seen Amigas doing Mandelbrots, and the lack of a math chip made them very slow compared to the Mac II. However, I have no intention of encouraging him by asking him in public!"

RS: 'nuff said. If you two (and perhaps others) want to continue this as a private forum:

George Zopf	Ken Philip
Box 239	1590 N. Becker Ridge Rd.
Arroyo Seco, NM 87514	Fairbanks, AK 99709

LETTERS

— From David B. Lewis

Dear Rollo,

Enclosed is my renewal check. It's good to see that you're making the newsletter a success.

I would like to see an increase in technical material back to the level of the first few issues. [I didn't think the Sir-Tech letter in #8 was appropriate; the story was pure drivel.]

I've moved off the VAX 11/780 and FORTRAN; I'm hoping to make some time to figure out how to use Sun color graphics.

I'll let you know of anything hot. Best,

— From Ian Entwistle

Rollo,

The references to various fractals in the last Amy indicated the interest Amy readers may have in "curve" fractals. I had meant to include comment on this book[1] in my bibliography (which is coming along only slowly), but it may be of interest now. It is an excellent book on computer graphics in general; very well written and illustrated. There are a large number of routines — they are in BBS BASIC. There are chapters on all aspects of graphics, but of particular interest are chapters 4 and 5. Chapter 5 contains listings for many fractals, including Koch, Peano, Sierpinski, Dragons, Cesaro, mountains, rivers, and planets. There is a lot of background information for those who find the articles in computer magazines a little short on explanation.

[1] Microcomputer Graphics (Art, Design and Creative Modelling); Michael Batty; Chapman and Hall, London (1987) (Included in the Amygdala bibliography as #84, below).

BIBLIOGRAPHY

117 sent in by Wm R Davis and Ian Entwistle.
119 sent in by Howard A Ashley.

84. M. Batty, "Microcomputer Graphics (Art, Design and Creative Modelling)". Chapman and Hall, London (1987) ISBN 0-412-28530-4 (hardback), 0-412-28540-1 (paperback). [See the review contained in Ian Enwistle's letter, above.]

85. R Delbourgo, "Fascinating Fractals: Geometry of Nature", *Rainbow* 2,12 (July 1983) 28-30. ["Provides a program listing that will calculate and draw fractal shapes: fractal trees, fractal cornered squares, fractal edged squares. Written in BASIC for the Radio Shack Color Computer."]

86. "A fractal universe?" (universe must have more dimensions than we perceive), *Science News* 129 (April 5, 1986) 217.

87. (Cover picture) *Science News* 132,12 (September 19, 1987). "Computer graphics provides a striking new way of looking at mathematical equations. The cover image was generated by plotting the behavior of points governed by a particular set of differential equations. Each different starting point evolves into a colored line. Together, the lines become a kind of "portrait" of the equation. (Image: Pickover/ IBM)"

88. I Peterson, "Portraits of Equations", *Science News* 132,12 (September 19, 1987) 184-186. [Discusses Clifford Pickover's work in expressing the properties of equations by means of graphic images. 4 colored pictures.]

89. C Grebogi, E Ott, JA Yorke, "Chaos, Strange Attractors, and Fractal Basin Boundaries in Nonlinear Dynamics", *Science* (30 Oct 1987). [Some nifty graphics of chaotic attractors.]

90. J Gleick, "Chaos: Making a New Science". Viking, 1987. [And see #91.]

91. M Gardner, "Order in Chaos", *Boston Sunday Globe* October 4, 1987. [Reproduced in Amygdala #8]

92. KM Crennell, "Mandelbrot Graphics", *Beebug* 1,5 (May 1986). [Contains BBC-B listings.]

93. RD Harding, DA Quinney, "A simple introduction to numerical analysis", Adam Hilger 1986.

94. D Johnson-Davies, "Join the Mandelbrot Set", *Acorn User* 46 (May 1986) 80. [Contains BBC-B listings.]

95. D Johnson-Davies, "Back to the Roots", *Acorn User* 48 (July 1986) 88. [Contains BBC-B listings.]

96. D Johnson-Davies, "Return of the Mandelbrots", *Acorn User* 58 (May 1987) 81. [Contains BBC-B listings.]

97. H-O Peitgen, D Saupe, "Julia, a scheme for the generation of self-similar images", *Computer Graphics ACM SIGGRAPH* (1984?)

98. C Reynolds, "Psychebrot, an animated demonstration of the Mandelbrot Set", *CODIL Language Systems* 33 Buckingham Road, Tring, Herts, ENGLAND.

99. R Taylor, "Understanding the Mandelbrot Set", *Micromath* 2,2 (1986)

100. L Nottale & J Schneider, "Fractals and nonstandard analysis", *J Math Phys* 25(1984) 1296-1300 ["it seems rather superficial"].

101. M Hazwinkel, "Experimental Mathematics", Computers and Mathematics and Applications (ed. de Bakker, Hazwinkel, Lenstra), *Proc. of the Nov 1983 Symposium on Math & Computer Sci* (CWI / North Holland 1984).

102. J Shallit, "Two Methods for the Generation of Fractal Images", University of Chicago Technical Report 87-010 (June 1987). [Discusses two methods of generating images of fractals and fractal-like sets involving iteration of matrix processes which generate rectangular arrays of intensity levels particularly suited for display on bitmap raster devices. The methods also give efficient parallel algorithms for computing nxn images in time proportional to log(n) operations per pixel.]

103. (See #9) C Dodge, "Musical fractals", *BYTE* 11,6 (June 1986) 185-196. "Mathematical formulas can produce musical as well as graphic fractals". ["The article provides programs for creating musical fractals on a personal computer and discusses some computer-aided music composition techniques, including three kinds of random process: white noise, Brownian noise, and fractional noise. They are written in MSX BASIC extended with the MUSIC MACRO commands for the Yamaha CX5-M music computer. Discusses the relationship between numbers and music, composing by computer, fractals and musical structure, and a layered structure. 11 figures, 7 references."]

104. (See #22) PR Sørenson, "Fractals: Exploring the rough edges between dimensions". *Byte* 9,10 (September 1984) 157-172. ["Describes fractals and their relationship to computer graphics. Includes a program that generates images of fractals written in Applesoft BASIC. 11 photos, 6 figures, 2 references."]

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MEGABROT CARD. The folks at MegaGraphics, Inc. have developed a Mandelbrot Set Generator interface card called *MegaBrot* for the Macintosh II which cruises along at five million iterations per second. Diane Scott kindly sent me several copies of a poster of images produced by this board. Copies of the poster are available for $13.50 postpaid ($14.15 in California) from:

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